High Strain Rate Superplastic Behavior of Al-Li-Mg-Cu-Sc Alloy Subjected to Severe Plastic Deformation

M.R. Shagiev[1,2], Y. Motohashi[1], F.F. Musin[2], R.O. Kaibyshev[2]

[1] *Research Center for Superplasticity, Faculty of Engineering, Ibaraki University, 4-12-1 Nakanarusawa, Hitachi, 316-8511, Japan*

[2] *Institute for Metals Superplasticity Problems, Russian Academy of Sciences, 39 Khalturin Str., Ufa, 450001, Russia*

A novel commercial Al-Li-Mg-Cu-Sc alloy is considered as an advanced material for fuselage skin due to optimal combination of strength, crack propagation resistance and workability. Achievement of superplasticity in this alloy will allow developing a superior high-strength aluminium alloy which can be superplastically formed into complex aerospace components. Two different processing ways were applied to refine the microstructure of the alloy. The first one was equal-channel angular extrusion (ECAE) at 325°C to the total true strain of ~16 and the second – hot rolling at 300°C with the total reduction in thickness of 90%. Both routes of severe plastic deformation resulted in formation of partially recrystallized microcrystalline structure with the mean size of recrystallized grains of 3 μm and 25-35% of non-recrystallized areas containing recovered subgrains.

Superplastic properties of the alloy were studied in the temperature range of 350-525°C and at strain rates of 1.4×10^{-3}-1.4×10^{-1} s^{-1}. In both conditions the total elongations of about 400% were obtained at 450°C and strain rate of 1.4×10^{-2} s^{-1} indicating a high strain rate superplasticity. In the ECAE condition the ductility maximum of 650% appeared at 450°C and a strain rate of 1.4×10^{-3} s^{-1} with corresponding coefficient of strain rate sensitivity of 0.42. While after hot rolling material exhibited smaller elongations (about 415%) and some anisotropy of in-plane mechanical properties of the sheet.

Superplastic deformation led to considerable improvement of microstructure homogeneity suggesting an occurrence of dynamic recrystallization within initial unrecrystallized areas. After deformation under the optimum superplastic conditions, the volume fraction of non-recrystallized areas decreased to as low as 0.5% in the ECAE condition and to 5% in the hot rolled one. The higher homogeneity of microstructure in the ECAE condition resulted in lower cavitation during superplastic deformation as compared to the hot rolled condition.

Contact Author: M.R. Shagiev

Organization: Research Center for Superplasticity, Ibaraki University

Address: 4-12-1 Nakanarusawa, Hitachi, Ibaraki, 316-8511, Japan
(City, State, Zip Code, Country)

Phone: +81-0294-38-5264 (ext.8209)

Fax: +81-0294-38-5032

E-mail: shagiev@mx.ibaraki.ac.jp

Co-authors: Y. Motohashi

Phone: +81-0294-38-5032

Fax: +81-0294-38-5032

E-mail: motohashi@mech.ibaraki.ac.jp

Co-authors: F.F. Musin

Phone: +7-3472-253856

Fax: +7-3472-253856

E-mail: fanil@anrb.ru

Co-authors: R.O. Kaibyshev

Phone: +7-3472-253856

Fax: +7-3472-253856

E-mail: rustam@anrb.ru